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Effect of Tithonia (*Tithonia diversifollia*) Compost and *Trichoderma* sp. Coating on Potato (*Solanum Tuberosum* L.) Growth and Yield

Zulfardi Ashar[1,3], Elkawakib Syam'un[2*], Fachirah Ulfa[2] and Ifayanti Ridwan Saleh[2]

[1]Doctoral Program of Agricultural Science, Graduate School, Hasanuddin University, Makassar, Indonesia;[2]Department of Agronomy, Faculty of Agriculture, Hasanuddin University, Makassar, Indonesia;[3]Agricultural Product Technology, Faculty of Agriculture, Sulawesi University of Technology, Makassar, Indonesia
*Corresponding author's e-mail: elkawakibsyam@gmail.com

This study aimed to evaluate the effects of *Trichoderma* sp. coating and Tithonia compost application on potato growth and production. The research was conducted in Pattapang Village, Tinggimoncong District, Gowa Regency, from January 2023 to November 2023. This study was designed in a factorial design with two factors. The first factor was the coating, which consisted of no coating and with coating. The second factor was the dosage of Tithonia compost, which included 0 kg/plot, 3 kg/plot, 6 kg/plot, 9 kg/plot, and 12 kg/plot. Based on the research results, the interaction between *Trichoderma* sp. coating and Tithonia compost application had a significant effect on plant height, leaf number, tuber number, tuber weight, stomatal opening area, stomatal density, and chlorophyll content (a, b, and total). The effect of Tithonia compost dosage was significant on tuber diameter and tuber length. Additionally, the effect of *Trichoderma* sp. coating was significant on vitamin C content.
Keywords: Coating, compost, potato, *Trichoderma* sp., tuber, Tithonia compost, Potato growth, Potato production, Coating effects, Factorial design, Plant height, Leaf number.

INTRODUCTION

Potato plants are one of the essential commodities used as staple food besides rice and also support efforts to diversify food sources. According to Gunarto (2003), potatoes are a superior horticultural commodity with high economic value. Therefore, the Ministry of Agriculture of the Republic of Indonesia targets a continuous increase in potato production every year. Potato cultivation is widely carried out in highland areas (800-1800 meters above sea level) (Tayanan *et al.*, 2023), with the majority of production occurring in regions such as West Java, Central Java, South Sulawesi, North Sumatra, West Sumatra, and Jambi (Tayanan *et al.*, 2023). Potato production in Indonesia increased from 2016 to 2021, with 1,213,041 tons produced in 2016 and 1,361,064 tons produced in 2021. In South Sulawesi, potato production fluctuated from 2016 to 2023. In 2016, production reached 540,155 tons; in 2017, 506,285 tons; in 2018, 569,544 tons; in 2019, 622,218 tons; in 2020, 611,831 tons; in 2021, 722,663 tons; in 2022, 801,103 tons; and in 2023, 858,222 tons (BPS, 2023). Although potato production in South Sulawesi tends to increase, innovations are still needed to further develop potato production in the region. Productivity and soil quality can be improved with the addition of organic materials. One potential organic resource for sustainable development is Tithonia. Adding Tithonia compost will increase nutrient absorption by plants, enhance the soil's water retention capacity, improve plant growth, stimulate soil biology, be environmentally friendly, and reduce farmers' dependence on chemical fertilizers by utilizing local resources (Dwipa, 2017). Tithonia is a refugia plant that typically grows wild along roadsides or in fields. According to Hakim and Agustina (2012), its average dry biomass can reach 2-5 tons per hectare per year. Tithonia contains nitrogen (N) ranging from 3.1% to 5.5% and phosphorus (P) from 0.2% to 0.55%. Compost made from Tithonia has high potential for soil fertility restoration, positively impacting soil fertility, particularly phosphorus content (Phiri *et al.*, 2001). The addition of Tithonia compost offers many benefits for potato cultivation; however, it must be combined with *Trichoderma* sp. to achieve optimal results and protect against Fusarium fungi. *Trichoderma* sp., as a decomposing organism, can be utilized as a biological agent and plant growth stimulator. *Trichoderma* sp. can be combined with compost and then applied to plants, acting as a biodecomposer of organic waste into high-quality compost and as a

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biofungicide (Simamora, 2022). Fitria *et al*. (2021) reported that applying Trichoderma seven days before planting was able to suppress Fusarium fungus attacks and enhance the growth of tomato plants, which are related to potato plants. Research by Sopialena (2015) also reported that the application of *Trichoderma* sp. to tomato plants could suppress Fusarium fungus attacks by up to 24.50%. *Trichoderma* sp. is a fungus capable of producing various compounds that induce plant resistance to pathogen attacks and adverse environmental conditions. Therefore, *Trichoderma* sp. can serve as a biological agent that suppresses the growth of pathogenic fungi (Simamora, 2022). Based on the above explanation, this research was conducted to study the effects of applying various doses of Tithonia compost and Trichoderma on potato production.

MATERIALS AND METHODS

***Research Location and Experimental Design*:** This research was conducted in the Pattapang Village, Tinggimoncong District, Gowa Regency. The research was carried out from January 2023 to November 2023.

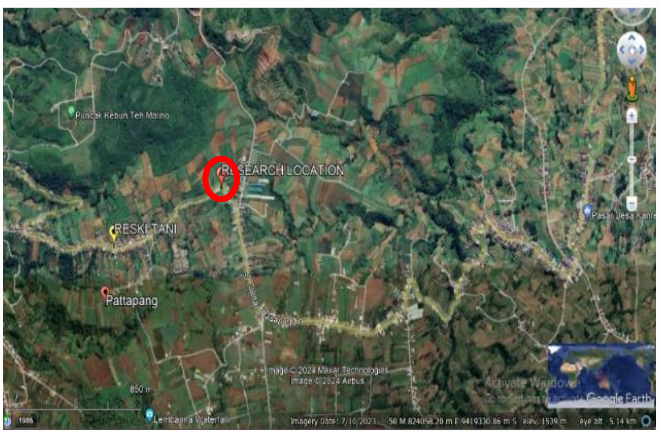

Figure 1. Pattapang Village,Tinggimoncong District, Gowa Regency (823,395.00 mE, 9,419,391.00 mS).

This study was designed in a factorial design with two factors. The first factor is the coating, which consists of no coating (T0) and with coating (T1). The second factor is the dosage of Tithonia compost, which includes control (K0), 3 kg/plot (K1), 6 kg/plot (K2), 9 kg/plot (K3), and 12 kg/plot (K4). The combination of these two factors resulted in 10 treatment combinations, each repeated three times, resulting in a total of 30 observational units. The characteristics of the soil on the experimental plot are detailed in Table 1.

***Research Procedure*:** The coating process with *Trichoderma* sp. as described by Umadi (2018) involves the following steps: (a) placing potato tubers into a granulator, (b) spraying a small amount of water to make the tubers moist, (c) once the tubers are moist, the next step is to add *Trichoderma* sp. while the granulator is in operation, and (d) continue operating the granulator for five minutes or until *Trichoderma* sp. fully covers the potato tubers. After the coating process, the treated tubers are planted in ridges with a spacing of 25 cm between plants. The spacing between ridges is 75 cm. The planted tubers are then covered with soil and watered until they are moist. The potato variety used is Granola. Maintenance involves weeding, watering, and controlling pests and diseases using organic pesticides.

***Data Collection and Analysis*:** The parameters measured in this study are: (a) plant height, (b) number of leaves, (c) number of shoots, (d) stomatal density, (e) stomatal aperture area, chlorophyll A, chlorophyll B, and total chlorophyll. The collected data were then analyzed using ANOVA. If significant effects were observed, further analysis was conducted using Tukey's test with a p-value <0.05. The experiments were performed on various coating factors at a single dose of Tithonia compost or on various doses of Tithonia compost at a single coating factor.

RESULTS

***Tithonia Compost Properties*:** Based on the chemical analysis of the Tithonia compost (Table 1), it was found that the pH of the compost is 6.59, and the organic content of C, N, P, and K are 18.25%, 0.75%, 0.51%, and 1.41%, respectively. The C:N ratio is 24.

***Vegetative Attributes*:** Based on the conducted research, it was found that the treatment of coating and the application of Tithonia compost had a significant effect, both individually and in interaction. For the parameters of plant height and leaf number, the interaction between coating and Tithonia compost showed significant effects (Figures 2A and 2B). The combination of no coating with the application of Tithonia compost at a dosage of 12 kg/plot recorded the highest average plant height of 185.0 cm; however, this was not significantly different from the treatment involving coating and Tithonia compost at the same dosage of 12 kg/plot. Furthermore, for the average number of leaves, the interaction between coating and Tithonia compost at a dosage of 12 kg/plot yielded the highest value of 154.0 leaves, which was

Table 1. Soil and tithonia compost properties.

No.	Sample	pH	C-organic (%)	N-organic (%)	C/N	P-organic (%)	K-organic (%)
1	Soil	5.11	1.42	0.14	10	-	0.22
2	Tithonia Compost	6.59	18.25	0.75	24	0.51	1.41

not significantly different from the interaction of no coating with Tithonia compost at the same dosage of 12 kg/plot.

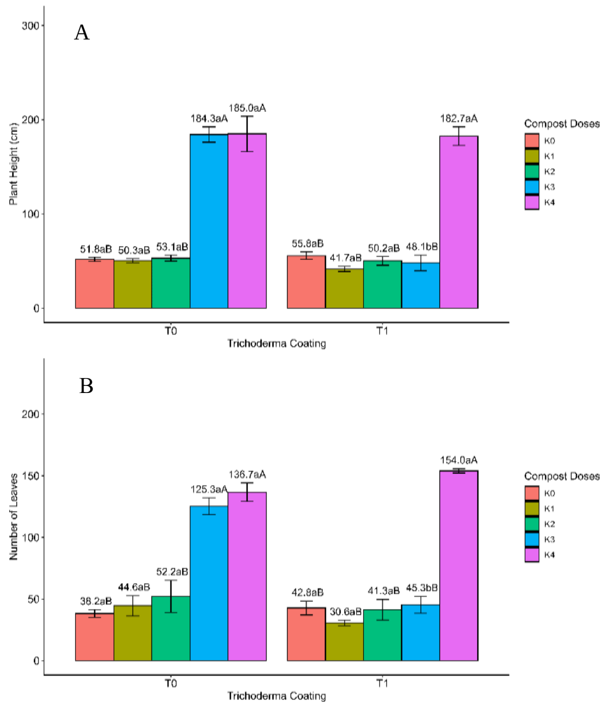

Figure 2. (A) Plant height and (B) number of leaves.

Tuber Attributes**:** For the parameters of bulb diameter and height, only the treatment involving the dosage of Tithonia compost had a significant effect. The application of Tithonia compost at a dosage of 12 kg/plot recorded the largest diameter, measuring 4.82 cm, and the tallest bulb, measuring 8.30 cm, which were significantly different from the other dosage treatments (Figures 3A and 3B). In contrast, the parameters of bulb number and bulb weight were influenced by the interaction of both treatment factors. The interaction between coating and the application of compost at a dosage of 9 kg/plot resulted in the highest average number of bulbs per plant; however, this was not significantly different from the treatment without coating at the same dosage (Figure 3C). Additionally, the interaction between coating and the application of Tithonia compost at a dosage of 12 kg/plot resulted in the heaviest bulb weight, measuring 136.1 g, but this was not significantly different from the treatment without coating at the same dosage (Figure 3D).

Stomata Traits, Chlorophyll, and Vitamin C**:** The parameters of stomatal opening area and stomatal density were influenced by the interaction of both treatment factors. The interaction between coating and the application of Tithonia compost at a dosage of 12 kg/plot recorded the largest average stomatal opening area, measuring 451 µm², which was not significantly different from the treatment without coating at the same dosage (Figure 4A). Conversely, the interaction between no coating and no application of Tithonia compost resulted in the highest stomatal density, measuring 82.4 stomata/µm², which was significantly different from all other treatment combinations (Figure 4B).

The interaction between coating and the application of Tithonia compost at a dosage of 12 kg/plot consistently

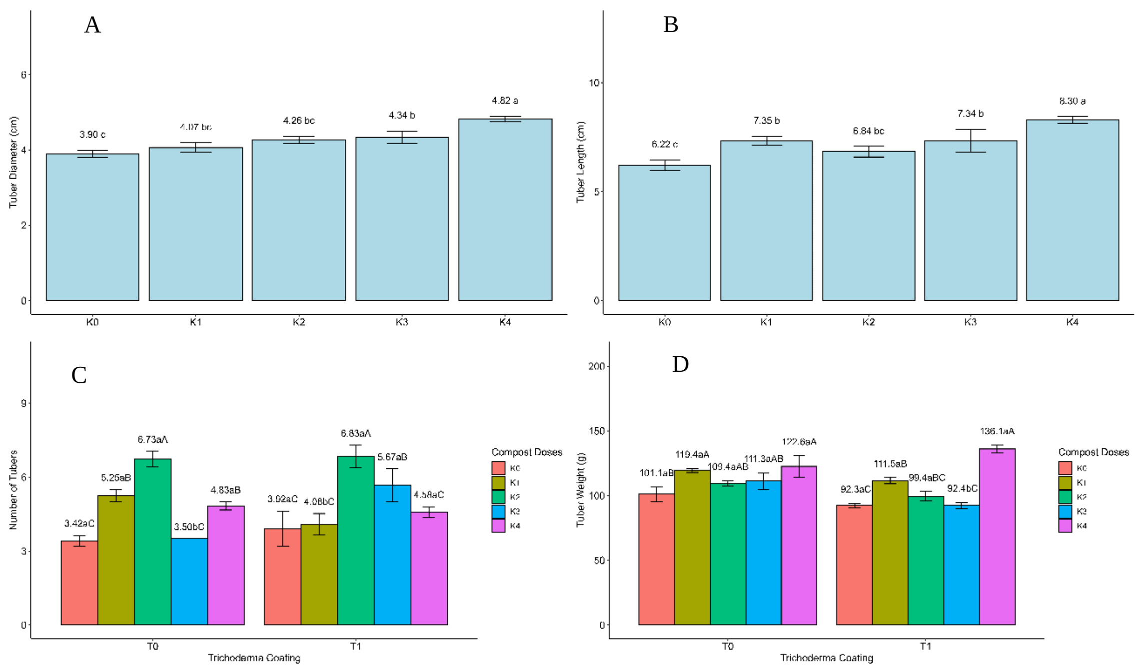

Figure 3. (A) Tuber diameter, (B) tuber length, (C) number of tubers, and (D) tuber weight.

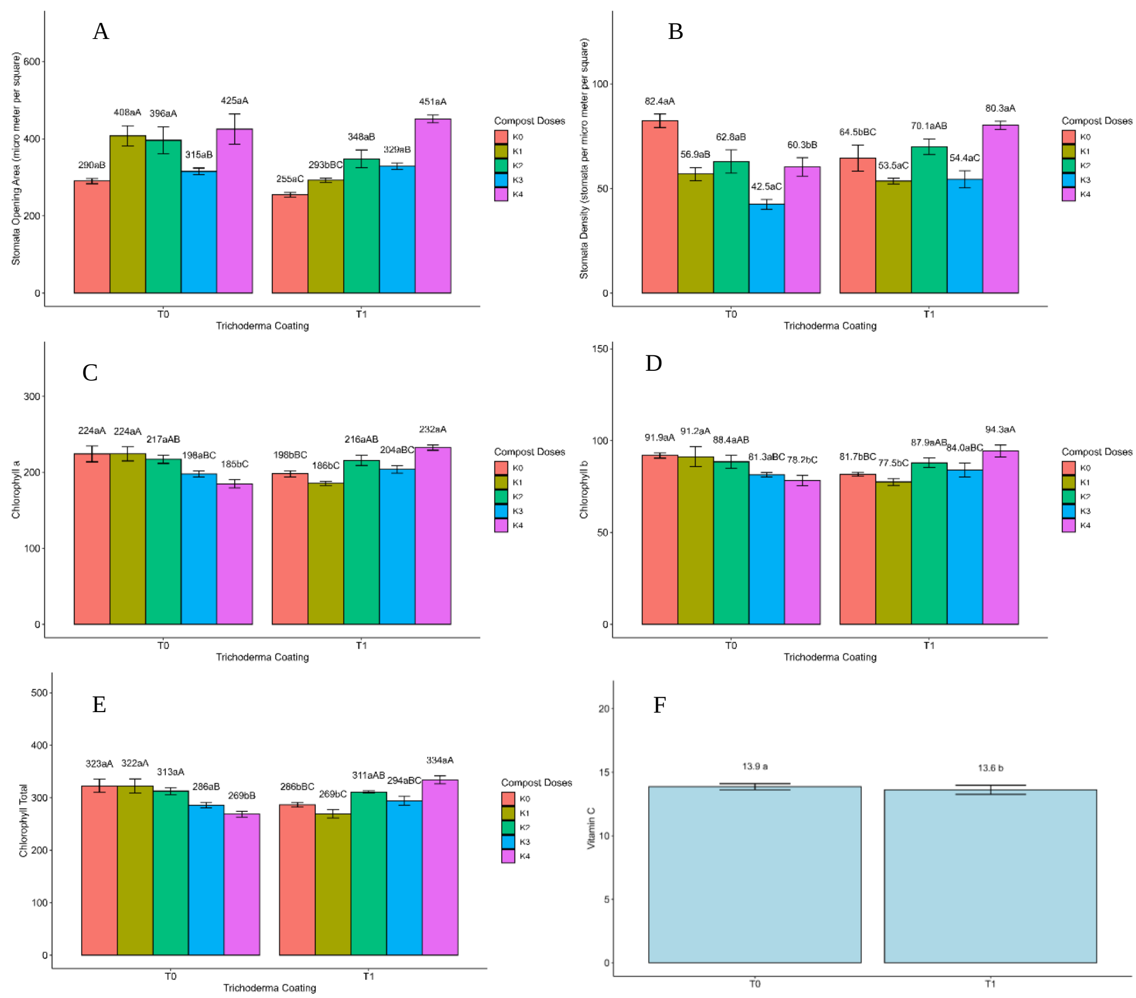

Figure 4. (A) Stomata opening area, (B) stomata density, (C) chlorophyll a, (D) chlorophyll b, (E) chlrophyll total, (F) vitamin C.

recorded the average concentrations of chlorophyll a, b, and total chlorophyll, measuring 232 µg/g, 94.3 µg/g, and 334 µg/g, respectively. These values were significantly different from all other treatment combinations (Figures 3C, 3D, and 3E). Furthermore, the highest vitamin C concentration in the bulbs was observed in the treatment without coating, measuring 13.9 mg, while the treatment with coating recorded a concentration of 13.6 mg (Fig, 3F).

DISCUSSION

The compost qualities in Table 1 are based on laboratory tests. The Tithonia compost's pH of 6.59 is excellent for potato growing, which thrives in a pH range of 5 to 6.5 (Jama, 2000). With Tithonia compost, soil pH can reach 6.59 (Syofiani, 2019). Chemical, physical, biological, and environmental soil quality can be improved by adding organic matter (Syofiani, 2019). Organic carbon and nitrogen increased in Tithonia compost-treated soil. The organic composition of Tithonia compost increases organic carbon and nitrogen. The soil reacts with carbon dioxide from organic matter decomposition to generate carbonic acid, which boosts plant development. Nitrogen, which most cultivated plants prefer or absorb, is released by soil organic matter (Dewanto *et al.*, 2017). The breakdown of soil-bound phosphorus is affected by Tithonia compost's 0.51% organic acid. Organic acids created during Tithonia plus organic fertilizer (POTP) decomposition can dissolve soil phosphorus, according to Syofiani (2019). Decomposing organic materials releases organic acids that dissolve potassium in soil, raising potassium level to 1.41% (Syofiani, 2019). The vegetative phase is greatly impacted by 12 kg/plot Tithonia compost, both coated and uncoated. Combining Trichoderma and Tithonia compost treatments can increase soil pH, organic carbon, accessible phosphorus, potassium, and nitrogen, which plants need. The nitrogen content in Tithonia compost

is six times higher than the available nitrogen in the soil, amounting to 0.75% (Tables 1 and 2), and plays a crucial role in the formation of vegetative plant parts, including plant height. According to Abdullah (2022), the primary role of nitrogen is to accelerate overall plant growth, particularly in stems and leaves.

The interaction between Trichoderma coating and Tithonia compost results in a higher average number of leaves compared to untreated plants. This is because nitrogen promotes overall growth, especially in stems, leaves, and branches (Dwipa, 2017). Husnain (2016) reported that nitrogen is an essential nutrient for enhancing plant growth, improving leaf health, and making leaves wider with a greener color. Generally, nitrogen is crucial for the formation and growth of plant parts such as leaves, stems, and roots. This is because Tithonia compost provides sufficient nutrients, rich in nitrogen content at 3.76%, which can stimulate photosynthesis (Rahayu *et al*., 2021). High photosynthetic rates can accelerate photosynthetic processes, leading to plant development and the formation of new shoots (Buntoro, 2014). The rate of photosynthesis increases with stomatal breadth and density. Plants can absorb nutrients from trichoderma covering. Trichoderma coating contains phytohormones and enzymes that promote plant growth, according to Bina *et al*. (2022). In Trichoderma coating, enzymes breakdown phosphates, making them available to plants. Trichoderma coating phytohormones directly affect plant shoot growth.

Environmental elements like light intensity, temperature, air humidity, and soil nutrients affect chlorophyll levels. Tithonia compost and Trichoderma coating alter leaf chlorophyll. Trichoderma coating breaks down soil organic matter and provides plant nitrogen (Zani and Anhas, 2021). Tithonia compost includes nitrogen, which helps leaves synthesize chlorophyll and turn green (Rahayu, 2023). Increased chlorophyll helps plants collect sunlight and accelerate photosynthesis. Zaiyou (2022) found that high chlorophyll levels boost photosynthesis. Leaf chlorophyll is essential to photosynthesis. More chlorophyll in leaf tissues increases photosynthetic activity. Photosynthesis transfers energy and carbohydrates throughout the plant, encouraging potato development and storing in tubers.

***Conclusion*:** Based on the research results, the interaction between *Trichoderma* sp. coating and Tithonia compost application had a significant effect on plant height, leaf number, tuber number, tuber weight, stomatal opening area, stomatal density, and chlorophyll content (a, b, and total). The effect of Tithonia compost dosage was significant on tuber diameter and tuber length. Additionally, the effect of *Trichoderma* sp. coating was non-significant on vitamin C content.

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***Informed consent*:** N/A.

***Consent to participate*:** All authors participated in this research study.

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***SDGs addressed*:** Zero hunger, Responsible consumptions and production.

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